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Modeling Mixed Layer Flow Under Leads In Sea Ice

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OBJECTIVES

The objectives of this study are to examine convectively driven mixed layer circulations under leads in Arctic Ocean sea ice. A specific goal is to determine under what circumstances eddy formation is favored and do the eddies which are generated in leads have chracteristics of those seen in observations of Arctic mixed layer eddies.

APPROACH

During the previous several years of support, a nonhydrostatic high resolution convection model has been developed for the study of ocean flow beneath leads in sea ice. The results obtained thus far have been for two dimensional flow fields. Recently however, the model has been adapted to three dimensions. The three dimensional model is used in initial value and boundary forced numerical experiments in which a wide range of realistic lead conditions are simulated. These experiments are conducted where possible to coincide with comparable laboratory experimentation (also conductedhere at ASU) on convection from line segment sources in rotating frames.

WORK COMPLETED

During 1999, the three dimensional, nonhydrostatic convection model has been used to simulate convectively driven motions under line segment sources for a widerange of lead dimensions and forcing parameters.

A series of high resolution experiments in which lead width, buoyancy flux(air-sea temperature difference), mixed layer depth and along lead irregularity in lead distribution has been conducted. The experiments represent a 30 km square domain which is 50 m deep.

RESULTS

Eddy generation is a common feature of convection under line segment sources and the sensitivity of this process to lead geometry and forcing parameters have been the central focus of the most recent experiments.

We have been able to quantify eddy characteristics in terms of lead width, buoyancy flux, duration of buoyancy forcing and along lead variability in the forcing. The eddy scales which result from variations in these parameters have been compared with comparable lab experiments which have also considered some of these variations.

Although there is favorable agreement between lab and numerical results, their scales and location in the water column appears at odds with observations of Arctic ocean halocline eddies.
A manuscript describing these results is in preparation.

ACCOMPLISHMENTS

This project initiated during the last month of FY97.

Initially the model was two dimensional. A paper documenting the two dimensional nonhydrostatic ocean flow associated with individual stationary and moving leads was accepted for publication during FY97 (Smith and Morison(1998).

During the conversion of the model from two to three dimensions, aspects of the model development were being tested in joint lab/numerical intercomparisons. The results of some of these intercomparisons (published in 1996,Lavelle and Smith) were included in an overview paper on small scale mixing in geophysical
flows (Fernando and Smith,1999).

RELATED PROJECTS

None